

[ WHAT IS CLAIMED IS:

- B1 14. (Amended) A battery pack comprising:
- a first case;
  - a second case smaller than the first case, the second case containing a plurality of battery cells and being disposed within the first case;
  - a radiator disposed in contact with the cells, the radiator having at least one surface for radiating heat conducted from the battery cells,
  - a first air passage formed between the first and second cases and defined at least partially by said at least one surface of the radiator, the first air passage being separated from the battery cells, and
  - at least one air outlet formed in the first case and in communication with the first air passage.

15. A battery pack in accordance with claim 14, wherein the radiator includes a plurality of ribs which are oriented generally parallel to the direction of airflow through the first air passage.

16. A battery pack in accordance with claim 14, wherein the cells are divided into a plurality of blocks and further comprising at least one second air passage provided between the blocks, the at least one second air passage being in communication with the first air passage.

17. A battery pack in accordance with claim 16, wherein the first radiator includes a plurality of ribs which are oriented generally parallel to the direction of airflow through at least one of the first and second air passages.

B2 18. (Amended) A battery pack in accordance with claim 14 further comprising elastic material interposed between the first and second cases.

19. A battery pack in accordance with claim 18, wherein the cells are divided into a plurality of blocks and further comprising at least one second air passage provided between the blocks, the at least one second air passage being in communication with the first air passage.

20. A battery pack in accordance with claim 18, further comprising an air inlet provided in the first case and connected with the first air passage, wherein the first air passage is defined by inner surfaces of the first case and continuous recesses provided in outer surfaces of the second cases.

21. A battery pack in accordance with claim 20, wherein each of the first and second cases has a generally box-like shape, and the first air passage starts at the inlet provided in the first case which is provided in an upper surface of the first case, proceeds along a first inner side surface of the first case, forks into two branches along two opposite second and third inner side surfaces of the first case connected to the first inner side surface, and terminates at first and second air outlets provided in a fourth inner side surface of the first case.

22. A battery pack in accordance with claim 21, wherein the second case includes first to fourth outer side surfaces corresponding to the first to fourth inner side surfaces of the first case, respectively, the radiator includes a radiator plate having a generally U-shaped cross section which continuously surrounds the first, second, and third outer surfaces of the second case, and the ribs are formed on outer surfaces of the radiator plate in the first air passage.

23. A battery pack in accordance with claim 22, wherein the elastic material is disposed along upper and lower edges of the first case such that the first air passage is hermetically isolated from the cells.

24. A battery pack in accordance with claim 20, wherein the cells are divided into a plurality of blocks and further comprising at least one second air passage provided between the blocks, the at least one second air passage being in communication with the first air passage.

25. A battery pack in accordance with claim 24, wherein

the cells are divided into two blocks and the radiator includes first and second radiator plates arranged in parallel, each radiator plate having a generally U-shaped cross section and surrounding one of the cell blocks, and

the second air passage is defined between the radiator plates.

26. A battery pack in accordance with claim 25, wherein the ribs are provided on outer surfaces of the first and second radiator plates in the second air passage.

27. A battery pack in accordance with claim 25 further comprising a third air outlet provided in the fourth inner side surface of the first case between the first and second outlets, wherein a first end of the second air passage is connected to the first air passage and a second end thereof is connected to the third air outlet.

28. A battery pack in accordance with claim 25, wherein the second air passage is hermetically isolated from the cell blocks.

~~29.~~ (New) A battery pack in accordance with claim ~~14~~, wherein the second case hermetically seals the battery cells from the first air passage.

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30. (New) A battery pack for a power tool comprising:  
a housing adapted to alternatively connect to the power tool and to a battery charger;  
an inner case disposed within the housing;  
a plurality of battery cells disposed within the inner case, the inner case substantially sealing the battery cells therein;  
a connector adapted to electrically connect the battery cells to a terminal of the battery charger;  
an air inlet formed in the housing and adapted to receive forced air from the battery charger;  
an air passage defined at least in part by an interior surface of the housing and an outer surface of the inner case, the air passage being in communication with the air inlet; and

forced air directors adapted to direct the forced air from the battery charger to the air passage in order to cool the battery cells.

31. (New) A battery pack as in claim 30, wherein the battery cells are divided into at least two blocks and a second air passage is disposed between the at least two blocks of battery cells, wherein the second air passage is in communication with the air inlet.

32. (New) A battery pack as in claim 30, further comprising at least one radiator disposed proximally to the battery cells and adapted to wick heat away from the battery cells.

33. (New) A battery pack as in claim 32, wherein the radiator comprises a plurality of ribs disposed generally in parallel.

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34. (New) A battery pack as in claim 32, wherein the housing comprises a resin and the radiator comprises a metal.

35. (New) A battery pack as in claim 32, wherein the radiator is covered with a heat conductive, electrical insulating material that contacts the battery cells.

36. (New) A battery pack as in claim 32, wherein every battery cell is thermally coupled to the radiator.

37. (New) A battery pack as in claim 30, wherein the battery cells are nickel metal hydride battery cells connected in series.

38. (New) A battery pack as in claim 30, wherein the battery pack comprises first and second air outlets, wherein forced air received by the air inlet is divided and a portion of the forced air is directed along a first path and exhausted through the first air outlet and a portion of the forced air is directed along a second path, and exhausted through the second air outlet.

39. (New) A battery pack as in claim 30, further comprising a temperature sensor in communication with at least one battery cell.

40. (New) A battery pack as in claim 30, wherein the battery cells are adapted to begin charging when the connector contacts a charging terminal of a battery charger.

41. (New) A battery pack as in claim 40, further comprising a temperature sensor in communication with at least one battery cell, wherein the battery cells are nickel metal hydride battery cells connected in series, the battery pack comprises first and second air outlets, wherein forced air received by the air inlet is divided and a portion of the forced air is directed along a first path and exhausted through the first air outlet and a portion of the forced air is directed along a second path, and exhausted through the second air outlet.

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42. (New) An apparatus comprising:  
a battery pack as in claim 41; and  
a power tool comprising a fan and a forced air outlet adapted to couple with the air inlet of the battery pack, wherein forced air generated by the power tool fan cools the battery cells during operation of the power tool.

43. (New) An apparatus as in claim 42, further comprising a battery charger comprising a fan and a forced air outlet adapted to couple with the air inlet of the battery pack, wherein forced air generated by the battery charger fan cools the battery cells during a battery charging operation.

44. (New) An apparatus comprising:  
a battery pack as in claim 30; and  
a power tool comprising a fan and a forced air outlet adapted to couple with the air inlet of the battery pack, wherein forced air generated by the power tool fan cools the battery cells during operation of the power tool.

45. (New) An apparatus as in claim 44, further comprising a battery charger comprising a fan and a forced air outlet adapted to couple with the air inlet of the battery pack, wherein forced air generated by the battery charger fan cools the battery cells during a battery charging operation.

46. (New) An apparatus comprising:  
a removable battery pack comprising a housing, a plurality of battery cells disposed within an inner case, the inner case being disposed within the housing, a connector coupled to the battery cells and adapted to connect to a terminal of a battery charger, an air passage defined between the housing and the inner case, and an air inlet formed in the housing and in communication with the air passage; and

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a battery charger comprising a housing, a terminal disposed on the housing and adapted to couple to the removable battery pack terminal, a fan disposed within the housing and a forced air outlet adapted to couple to the removable battery pack inlet, wherein the fan is arranged and constructed to force air through the forced air outlet and the air inlet into the removable battery pack in order to cool the battery cells during a charging operation.

47. (New) An apparatus as in claim 46, wherein the battery charger is arranged and constructed to automatically energize the battery charger terminal in order to charge the battery cells when the battery charger terminal contacts the battery pack connector.

48. (New) A battery pack as in claim 47, wherein the battery pack further comprises a temperature sensor in communication with at least one battery cell.

49. (New) An apparatus as in claim 46, further comprising a radiator disposed proximally to the plurality of battery cells and adapted to wick heat away from the battery cells during a charging operation.

50. (New) A battery pack as in claim 49, wherein every battery cell is thermally coupled to the radiator.

51. (New) A battery pack for a power tool comprising:  
a housing comprising charging and discharging terminals disposed on the housing for alternatively coupling with the power tool and a battery charger;  
a plurality of battery cells disposed within the housing;  
an air passage defined within the housing, thereby enabling cooling air to pass through the housing;  
a partition separating the air passage from portions of the battery cells connected to the charging and discharging terminals; and  
a heat conductive and electrically insulating material in communication with the battery cells and the air passage.

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52. (New) A battery pack as in claim 51, further comprising an air inlet defined within the housing and in communication with the air passage, the air inlet adapted to receive cooling air from the battery charger.

53. (New) A battery pack as in claim 52, further comprising first and second air outlets, wherein forced air received by the air inlet is divided and a first portion of the cooling air is directed along a first path and exhausted through the first air outlet, and a second portion of the cooling air is directed along a second path and exhausted through the second air outlet.

54. (New) A battery pack as in claim 52, wherein the air inlet is arranged and constructed to communicate with an air outlet defined in the power tool, the air inlet being adapted to receive cooling air from a fan disposed within the power tool.

55. (New) A battery pack as in claim 54, wherein the air inlet is also arranged and constructed to communicate with an air outlet defined in the battery charger, the air inlet being adapted to receive cooling air from a fan disposed within the battery charger.

56. (New) A battery pack as in claim 55, further comprising air directors for directing cooling air from the battery charger to the air passage.

57. (New) A battery pack as in claim 51, wherein the battery cells are nickel metal hydride battery cells connected in series.

58. (New) A battery pack as in claim 51, further comprising a temperature sensor in communication with at least one battery cell.

59. (New) A battery pack as in claim 51, wherein the battery cells are arranged and constructed to begin charging when the charging and discharging terminals contact a battery charger.

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60. (New) An apparatus comprising:  
a removable battery pack comprising a housing, a plurality of battery cells disposed within the housing, terminals coupled to the battery cells, an air passage disposed within the housing, an air inlet defined within the housing and in communication with the air passage, a partition separating the air passage from the terminals coupled to the battery cells and a heat conductive, electrically insulating material in communication with the battery cells and the air passage; and  
a battery charger comprising a housing, terminals disposed on the housing and arranged and constructed to communicate with the battery pack terminals, a fan disposed within the housing, and a forced air outlet defined to communicate with the battery pack air inlet, wherein the fan is arranged and constructed to force cooling air through the forced air outlet and through the air inlet and across the heat conductive, electrically insulating material, so as to cool the battery cells during a battery charging operation.

61. (New) An apparatus as in claim 60, wherein the battery charger is arranged and constructed to automatically energize the battery charger terminals in order to charge the battery cells when the battery charger terminals contact the battery pack terminals.

62. (New) An apparatus as in claim 61, wherein the removable battery pack further comprises a temperature sensor in communication with at least one battery cell.



63. (New) A battery pack comprising:  
a housing comprising an air inlet and an air outlet;  
a first case disposed within the housing, the first case containing a first plurality of battery cells;  
a second case disposed within the housing proximate to the first case, the second case containing a second plurality of battery cells;  
a first air passage defined by facing surfaces of the first case and the second case; and  
a second air passage defined by an interior surface of the housing and exterior surfaces of the first case and the second case; and  
wherein the first air passage and the second air passage are in communication with the air inlet and the air outlet.

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64. (New) A battery pack according to claim 63 further comprising a first radiator coupled to the first case and a second radiator coupled to the second case for radiating heat away from the first plurality of battery cells and the second plurality of battery cells, respectively.

65. (New) A battery pack according to claim 64 wherein the first radiator and the second radiator are in communication with the first air passage.

66. (New) A battery pack according to claim 64 wherein the first radiator and the second radiator each comprise ribs oriented substantially transversely to a longitudinal axis of the battery cells.

67. (New) A battery pack according to claim 66 wherein the radiator ribs are oriented generally parallel to the direction of airflow through the first air passage.

68. (New) A battery pack according to claim 64 wherein an interior surface of each of the first radiator and the second radiator contacts the first plurality of battery cells and the second plurality of battery cells, respectively.

69. (New) A battery pack according to claim 64 wherein the first radiator and the second radiator are each generally U-shaped and surround first, second, and third sides of the first plurality of battery cells and the second plurality of battery cells, respectively.

70. (New) A battery pack according to claim 69 wherein the first radiator and the second radiator are disposed generally in parallel with each other and are in communication with the first air passage and the second air passage to radiate heat away from the first plurality of battery cells and the second plurality of battery cells, respectively.

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71. (New) A battery pack according to claim 70 wherein the first air passage is defined by facing surfaces of the first radiator and the second radiator, and the second air passage communicates with non-facing surfaces of the first radiator and the second radiator.

72. (New) A battery pack according to claim 64 further comprising a third radiator coupled to the first case and a fourth radiator coupled to the second case, wherein the third radiator and the fourth radiator are in communication with the second air passage to radiate heat away from the first plurality of battery cells and the second plurality of battery cells, respectively.

73. (New) A battery pack according to claim 64, wherein the first plurality of battery cells and the second plurality of battery cells are thermally coupled to the first radiator and the second radiator, respectively.

74. (New) A battery pack according to claim 63 wherein the housing comprises at least first, second, and third sides, the first side generally perpendicular to the second and third sides, the second and third sides generally parallel to a longitudinal axis of the battery cells, wherein the air inlet is disposed in the first side and the air outlet is disposed in the third side.

75. (New) A battery pack according to claim 74 wherein the housing comprises fluid directors for directing air from the air inlet toward the second side of the housing and transversely across the longitudinal axis of the battery cells.

77. (New) A battery pack according to claim 63 further comprising an elastic material interposed between an interior surface of the housing and exterior surfaces of the first case and the second case.

77. (New) A battery pack as in claim 63, wherein the first case substantially hermetically seals the first plurality of battery cells from the first and second air passages and the second case substantially hermetically seals the second plurality of battery cells from the first and second air passages.

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78. (New) A battery pack comprising:  
a housing comprising an air inlet and an air outlet;  
a first case disposed within the housing, the first case containing a first plurality of battery cells and substantially isolating the first plurality of battery cells from an outside environment;  
a second case disposed within the housing proximate to the first case, the second case containing a second plurality of battery cells and substantially isolating the second plurality of battery cells from the outside environment;  
a first air passage defined by facing surfaces of the first case and the second case; and  
a second air passage defined by an interior surface of the housing and non-facing surfaces of the first case and the second case, wherein the first air passage and the second air passage are in communication with each other and with the air inlet and the air outlet.

79. (New) A battery pack as in claim 78, further comprising:  
a first radiator in contact with the first plurality of battery cells for radiating heat away from the first plurality of battery cells into the first air passage; and  
a second radiator in contact with the second plurality of battery cells for radiating heat away from the second plurality of battery cells into the first air passage.

80. (New) A battery pack according to claim 79 wherein the first radiator and the second radiator each comprise ribs oriented substantially parallel to the direction of airflow through the first air passage.

81. (New) A battery pack according to claim 79 wherein the first radiator and the second radiator are each generally U-shaped and surround first, second, and third sides of the first plurality of battery cells and the second plurality of battery cells, respectively.

82. (New) A battery pack according to claim 81 wherein the first radiator and the second radiator are disposed generally in parallel with each other and are in communication with the first air passage and the second air passage to radiate heat away from the first plurality of battery cells and the second plurality of battery cells, respectively.

83. (New) A battery pack according to claim 82 wherein the first radiator and the second radiator each comprise ribs oriented substantially parallel to the direction of airflow through at least one of the first air passage and the second air passage.

84. (New) A battery pack according to claim 78 further comprising an elastic material interposed between an interior surface of the housing and exterior surfaces of the first case and the second case.